

Further Development of Aperture: A Precise Extremely Large Reflective Telescope Using Re-configurable Elements

Completed Technology Project (2016 - 2018)



Project Introduction

One of the pressing needs for space ultraviolet-visible astronomy is a design to allow larger mirrors than the James Webb Space Telescope primary. The diameter of the rocket fairing limits the mirror diameter such that all future missions calling for mirrors up to 16 m in diameter or larger will require a mirror that is deployed post-launch. In response to the deployment requirement, we address the issues of this concept called "A Precise Extremely large Reflective Telescope Using Reconfigurable Elements (APERTURE) with both hardware experiments and software simulations. APERTURE will use a deployable membrane-like mirror. The mirror figure will be corrected after deployment to bring it into better or equal $\lambda/20$ deviations from the prescribed mirror shape, where λ (typically 400 nm-1 micron) is the operational wavelength. Instead of using the classical piezoelectric-patch technology, our concept is based on a continuous coating of a Magnetic Smart Material (MSM). We expect that the initially deployed mirror will not have a perfect figure. Thus our design uses magnetic write heads to produce stress in the MSM and improve the figure, post deployment. This Phase II NIAC proposal is to address two of the tall poles in the concept: (a) Can corrections on a large size be made and retained for a long enough time (> 1 week); (b) Can deployment be done in such a way that the figures corrections are small enough to be correctable via the MSM plus magnetic field, and at the same time, the in plane stresses as small enough to allow the stresses resulting magnetic field injected into the MSM plus magnetic fields to make the necessary corrections. Tall pole a will be primarily the responsibility of Northwestern University (NU) and b of University of Illinois Urbana-Champaign. NU will carry out overall scientific leadership and will coordinate and solicit input from GSFC, JPL, and NIST.

Anticipated Benefits

Northwestern University is attempting to develop a game changing technology for large deployable optical quality mirrors.



General APERTURE concept, before and after deployment (write head moves along the curved arm, while the curved arm rotates about the center axis) Credits: M. Ulmer

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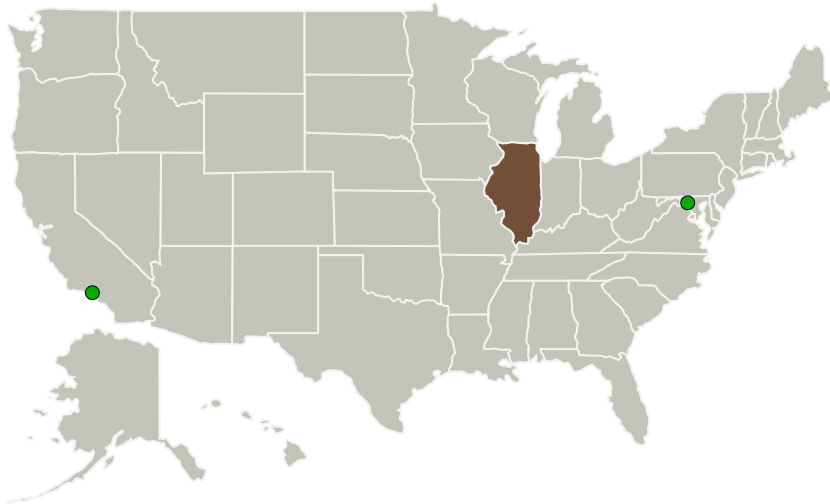
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Northwestern University	Lead Organization	Academia	Evanston, Illinois
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
National Institute of Standards and Technology(NIST)	Supporting Organization	US Government	Boulder, Colorado
University of Illinois at Urbana-Champaign	Supporting Organization	Academia	Urbana, Illinois

Primary U.S. Work Locations

Illinois

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Northwestern University

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Melville P Ulmer

Co-Investigators:

Yip-wuah Chung

Jian Cao

Victoria L Coverstone

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Project Transitions



July 2016: Project Start



June 2018: Closed out

Closeout Link: <https://www.nasa.gov/feature/further-development-of-aperture-a-precise-extremely-large-reflective-telescope-using-re>

Images



Project Image

General APERTURE concept, before and after deployment (write head moves along the curved arm, while the curved arm rotates about the center axis) Credits: M. Ulmer (<https://techport.nasa.gov/image/102132>)

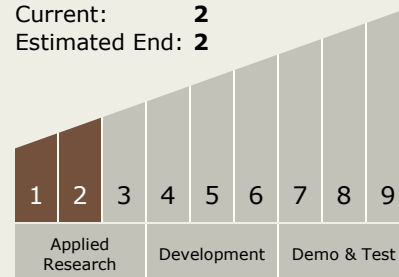
Links

NASA.gov Feature Article

(<https://www.nasa.gov/feature/further-development-of-aperture-a-precise-extremely-large-reflective-telescope-using-re>)

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.2 Observatories
 - └ TX08.2.1 Mirror Systems

Target Destination

Earth